Cyclonic damage to Plant Tissues

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(With two plates containing eight text-figures)

Following a cyclone in Madras the foliage of certain trees and shrubs exhibited marked symptoms of decay and defoliation. In *Azadirachta indica* the margins alone suffered decay while the remaining part of the lamina continued to function normally. A histological study of such leaflets indicates that the exposed cells of the lamina proliferate into wound tissue which contributes towards the reconstitution of a new margin. During this process the mechanism of regeneration is very similar to that described for leaf tissues subjected to artificial surgery.

On 3-xi-1966, the coastal regions of Madras City and neighbourhood suffered one of the worst cyclonic ravages. According to the official meteorological reports there was 61 mm. rainfall during 12 hours with a wind velocity of 120 km. per hour. In the city of Madras several trees were uprooted, branches mutilated, and the growing parts of many arborescent and shrubby plants that were directly exposed to the cyclone, damaged.

Various types of pathological reactivity were noticed on different genera of plants. In most of the relatively large, thin, simple leaved plants the lamina was subjected to severe degrees of tearing, the torn parts eventually dropping away. In *Minusops* and *Thespesia* the leaves turned uniformly yellow and got abscissed within 24 hours after the cyclone. In quite a number of genera possessing small or large simple leaves like *Cletodendron, Duranta, Lantana, Bougainvillea, Morinda,* etc., discoloration of the leaf margin was noticed immediately after the cessation of the gale; the leaves, however, remained intact on the trees for varying periods from one to two weeks. In the leaves of *Colophyllum, Morus* and *pongamia* the discoloration associated with desiccation extended centripetally throughout the laminal surface subsequent to which abscission followed. Discoloured lesions appeared as endemic spots on the leaves of *Lagerstroemia.*

The reaction exhibited by taxa possessing compound leaves belongs to a different category. In *Peltophorum* and *Delonix* the leaflets abscissed following discoloration while the gale was at its peak. In *Azadirachta indica* A. Juss. the margins of the leaflets to a distance

of 2 to 4 millimetres suffered discoloration associated with necrosis of the constituent cells. The first sign of discoloration and necrosis was noticed at the apex of the leaflet, soon spreading in the basipetal direction along the margins. At the optimum level of affectation the concerned area showed from outside (*a*) a blackish colour of lighter intensity merging into a darker pitch of the same colour and (*b*) a lighter green zone immediately adjoining the colour of the normal leaflet (Fig. 2). Separation of the affected area occurred interior to the light green zone. The affected area began drying up a day after the cyclone; on the next day it separated itself off from the lamina in the form of a dry, papery membrane. The most surprising phenomenon, however, is that the residual leaflets remained on the tree as long as the newly produced leaves or older leaves borne on that side of the tree which was not directly hit by the cyclone. In other words, in spite of the damage the residual leaflets appeared to carry on normal function. These leaflets simulate the shape of the normal ones obviously because of the discoloured zone which runs nearly parallel to the outline of the leaflet (cf. Figs. 1 & 3).

When the residual leaflet continues to take part in the metabolic activities, one naturally suspects a mechanism to 'heal' the exposed margins. The following account is concerned with a study of this phenomenon.

'Healing' process

In the normal leaflet the adaxial palisade tissue stops short of the extreme margin. Beneath the hypodermis along the margin is a nest of cells, the primary walls of which show thickenings similar to the collenchyma cells (Fig. 4). It is from this margin to a depth of 2 to 4 mm. that becomes affected. The zone 'A' deteriorates at a very rapid rate and as such the histological changes in this zone prior to decay could not be studied. In zone 'B' the first indication of the decay is seen in the slight enlargement of the mesophyll cells; the palisade cells increase slightly along the narrow diameter and the spongy cells increase in surface area. As a consequence, the cell alignment becomes disturbed more conspicuously in the spongy part of the mesophyll (Fig 5; cf. cells in 'B' zone with those in 'L'). The chloroplasts lose their typical green colour and the capacity to retain biological stains and the nucleus conspicuously shrinks in size exhibiting a rather amorphous structure.

With the decay being initiated in the zone 'B', the adjacent palisade cells begin to divide by walls parallel to the surface of the lamina.

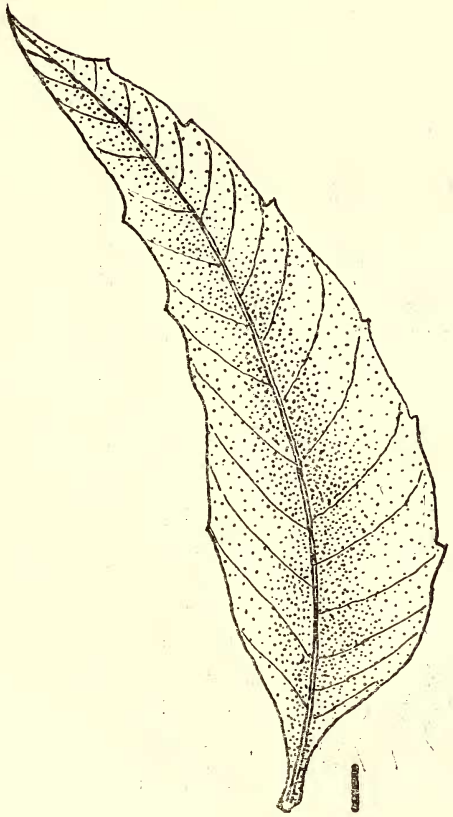
Although the width of this tissue exhibiting division from the zone 'B' varies slightly at different leaves of one and the same leaflet, on an average measures 300 microns. It is not all the cells of this tissue that undergo division and the largest number of cells show only one division wall particularly in the interior. Towards the edge, however, two or three walls could be seen in many cells which in turn undergo a division or two by walls at right angles to the surface. These cells enlarge and re-align themselves (*see* arrow in Fig. 6). In the spongy part of the mesophyll the exposed cells divide by walls parallel to the exposed surface. A larger number of divisions occur in these cells than in those of the palisade tissue and the thus formed tissue appears relatively more compact presenting a semblance of seriation (Fig. 7). It is quite possible that a few of the deep-seated cells of the spongy mesophyll also may initiate one or two divisions.

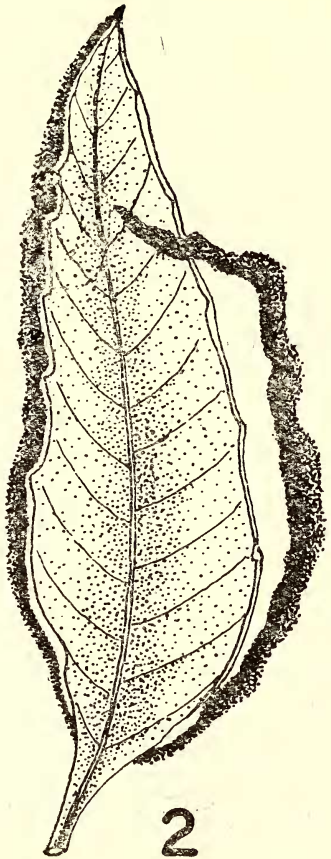
The newly produced cells of the spongy mesophyll sector soon lose their seriate arrangement partly due to slight enlargement and partly due to de-differentiation as oil secreting idioblasts (Fig. 8). A few of these cells also show the accumulation of tannin materials as in the normal tissue. It is noteworthy that the newly formed surface cells fail to develop cuticular deposits on their outer faces. On the other hand, their surface is covered over by the cutinised debris of zone 'B' (Figs. 7 & 8).

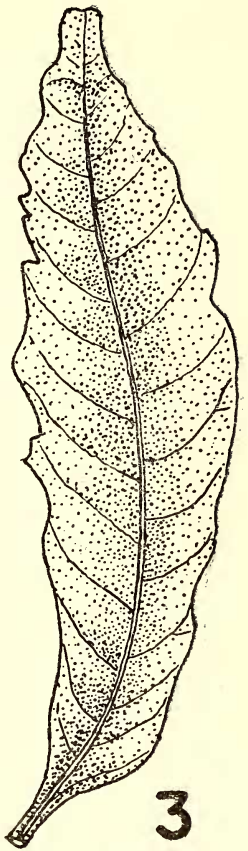
Discussion

A generalized sequence of events leading to the reconstitution of the exposed margin of the lamina following the decay of the true margin of the leaflet of *Azadirachta* involves (*a*) division of the superficial parenchyma cells by walls parallel to the surface resulting in (*b*) a provisional seriate arrangement of the derivative cells and (c) differentiation of these cells into some of the very cell types that is normally associated with the unaffected part of the lamina, like the secretory idioblasts and tanniferous cells. This sequence of events is not very different from that seen in the wound healing phenomenon in the dicotyledonous tissues. The degree of morphological expression of the phenomenon in the present case, however, is rather feeble.

With particular reference to the leaves of Dicotyledons the histological responses observed in the present case are somewhat similar to the condition described by Wylie (1930). He recognizes two zones in the affected tissues, pseudocicatrice and cicatrice. In the pseudocicatrice region the cells collapse as such (due to the loss of water from the exposed surface according to the author) and in the cicatrice







Figures 1 to 3: Fig. 1. Normal leaflet. Fig. 2. Deterioration and separation of the affected margin. Fig. 3. Leaflet after the falling away of the deteriorated part. (All figures $\times 1\frac{1}{2}$).